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# Army Manpower Cost Modeling

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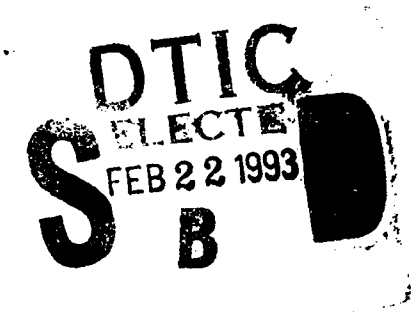


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LMI reviewed 12 models used by Headquarters, Department of the Army to prepare and analyze manpower budgets and life cycle cost (LCC) estimates. In addition, the potential of developing a single, multipurpose manpower costing model which could replace the existing models was evaluated.

Models were evaluated in terms of their cost coverage, user satisfaction, use of common data sources, and sustainment costs. The current set of manpower costing models was found to meet the Army's needs for budget and program preparation and LCC estimation and was well accepted by users. LMI found little duplication and overlap of function between the existing models although common data sources and elements were used. Specific recommendations to improve the current models were identified. The single, multipurpose model was not found to offer significant improvements in functional quality or cost savings.

Three recommendations were made to the Army.

- Not develop a single, multipurpose model but continue use of existing manpower costing models
- Explore consolidation of two reserve component budget models
- Conduct a verification and validation program on all manpower costing models.

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# *EXECUTIVE SUMMARY*

## INTRODUCTION

Analysts at Headquarters, Department of the Army (HQDA) currently use several manpower costing models to help them prepare and analyze budgets and to estimate life-cycle costs (LCC). We were asked to review these models and develop appropriate improvement alternatives. We were also asked to assess the option of developing a single, multipurpose model to replace the current set.

## DISCUSSION

We reviewed a total of 12 models. We found that 4 of the 12 could not be strictly described as manpower costing models for various reasons, so the 4 were excluded from further review. Of the remaining models that we examined in detail, 4 are budget preparation models. These are the Military Personnel, Army (MPA) Financial Management System; the Reserve Personnel, Army (RPA) Model Budget Formulation Module; the Reserve Component Financial Management System which we call the National Guard Bureau Personnel, Army (NGBPA) model; and the Civilian Manpower Obligations and Resources Decision Support System (CMORE DSS). One model, the put-and-take model, is solely a budget analysis tool. The remaining models, the family of three Army Manpower Cost System (AMCOS) models that estimate costs for active military, reserve military, and civilian manpower are designed primarily for LCC estimation but are also capable of budget analysis.



Budget models and LCC models differ in a number of ways. Each budget model addresses one appropriation (for example, the MPA addresses the Military Personnel, Army appropriation). Budget models use detailed inputs from various sources to produce outputs in specified formats for many budget activities, including basic pay, allowances, special pay, retirement accruals, and travel costs for permanent changes of station. Budget models are oriented on the budget and program years (near term, 2-7 years). On the other hand, LCC models support decision making on weapon systems acquisitions and force structure and allocate estimated costs to

several appropriations. They are oriented to long periods of time, such as 20 or 30 years, and work with data on an aggregated basis.

# CONCLUSIONS

Based on our review of these models and discussions with users and developers, we have drawn the following conclusions:

***The current set of models meets HQDA's needs for budget/program objective memorandum (POM) preparation and analysis and estimation of life-cycle costs.***

The cost elements that the models use (e.g., pay and allowances, costs for permanent changes of station, or training) are appropriate for the models' purpose. Users express satisfaction with the results of current models and, in most instances, the utility of the models they use, although several models have improvements under development to make them easier to use.

***A single multipurpose model will produce no significant improvement in functional quality or cost advantage.***

We have examined the prospect of increased quality stemming from the establishment of a single, multipurpose model and found that little potential exists for any breakthroughs in this arena. We have also examined the economic aspects of developing a new model and found that potential cost savings are minimal, at best. Annual sustainment costs of such an ambitious model are likely to approach the current costs of sustaining the present set of models (about $1.5 million in FY92 for contractor costs alone). Furthermore, development costs are likely to be much greater than any minor savings obtained by reducing annual sustainment costs.

***Some improvements can be made to the current set of models.***

We identified two initiatives that can be undertaken to improve the current set of models.

- We found that both the RPA and NGBPA models perform a budget preparation function for reserve military manpower. We conclude that reconsolidation of these two models (they were a combined model at one time) could provide advantages in reduced annual model sustainment costs and, perhaps more importantly, in an improved analytical capability for the Office of the Chief, Army Reserve.

- The models we reviewed have not had the benefit of a rigorous quality control and assurance program, such as a verification and validation (V&V). We conclude that a V&V would improve each model in the current set of models by identifying faulty algorithms, incorrect uses of data, and documentation shortfalls.

# RECOMMENDATIONS

We offer the following recommendations:

***The Army should not develop a single, multipurpose model but should continue the use of existing manpower costing models.***

***The Army should explore consolidation of the NGBPA and RPA models.***

***The Army should conduct a verification and validation program on all of its manpower costing models.***

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# CHAPTER 1

# ARMY MANPOWER COST MODELING

## INTRODUCTION

### OBJECTIVE AND SCOPE

Army manpower costing at Headquarters, Department of the Army (HQDA) currently utilizes a variety of independent models. We examined this set of models to determine if they are doing the job that is required of them and if improvements or efficiencies could be gained by developing a single model to replace the current set of models. Our investigation was limited in scope to those models currently in use at HQDA. It was limited in depth, in that our evaluation was not a full-scale verification and validation (V&V) of the models but rather an examination of model characteristics and user opinion.

### ORGANIZATION

In Chapter 2, we present a classification of Army manpower costing models and a brief description of each of the models reviewed. More detailed descriptions are provided in Appendix A.

Chapter 3 discusses our evaluation of the current set of Army manpower costing models. The evaluation focuses on the coverage of the models in terms of purposes and manpower categories and the user's satisfaction with the current set of models.

The desirability of a single, multipurpose model to replace the current set is examined in Chapter 4. We investigate the potential for a single model to improve the functional quality or to be less costly than the current set of models. Finally, our recommendations are presented in Chapter 5.

# CHAPTER 2

# MODEL DESCRIPTION

## INTRODUCTION

In this chapter we classify and describe the manpower costing models we reviewed. Table 2-1 lists the models reviewed, the office or offices that use the model, and a brief description of each model's application.

We limited the models we investigated to those used to prepare and analyze budgets and programs or estimate life-cycle costs (LCC) at the HQDA level. The primary function of these models is to develop the costs of Army personnel or to develop personnel costs as primary inputs to larger, more inclusive analyses.

Not all models with personnel costs fit our limitation. We did not include models used outside HQDA even if they could be applied to Army personnel. Models designed for other purposes, such as force-on-force simulations, transportation requirements models, or special-purpose costing models may include manpower costs as a secondary function. For example, the model developed for the base closure and realignment study, was not considered a manpower costing model.

## CLASSIFICATION OF MODELS

Manpower costing models at HQDA are used for three purposes. These aims include budget and program development, budget and program analysis, and LCC estimates.

Models with particular characteristics, such as utilizing particular inputs and producing particular outputs, are required to meet each task. For example, a model such as the Military Personnel, Army (MPA) Financial Management System that is used for budget development must be able to process the force profile of the entire active Army and produce as its output

the entire active Army MPA budget in budget-level detail. In contrast, a model such as the Army Manpower Cost System (AMCOS) (active) model may only use the manpower profiles of those units involved with a particular weapon system but produce manpower costs in several appropriation categories.

**Table 2-1. Manpower Cost Models Reviewed**

| Model | Proponent/ user | Application |
|---|---|---|
| MPA Financial Management System | ASA(FM) ODCSPER | Prepare MPA budget for active Army military manpower |
| Reserve Personnel, Army (RPA) Budget Formulation Module | OCAR | Prepare military manpower budget for US Army Reserve |
| Reserve Component Financial Management System, the National Guard Bureau Personnel, Army (NGBPA) | NGB | Prepare military manpower budget for Army National Guard |
| Civilian Manpower Obligations and Resources Decision Support System (CMORE DSS) | ASA(FM) | Support civilian manpower budget and programming requirements for AC and RC |
| Put-and-take | ASA(FM) | Adjust MPA budget for active Army, estimate marginal changes to budget for active Army |
| AMCOS (active) | CEAC | Military manpower LCC estimates and macro budget analysis for active Army |
| AMCOS (reserve/guard) | CEAC | Military manpower LCC and macro budget analysis for the USAR/ARNG |
| AMCOS (civilian) | CEAC | Civilian manpower LCC and macro budget analysis for army (both AC and RC) |
| West Point | ODCSPER | Ad hoc analyses of budget and LCC; not a model |
| Individual Training Predictive Model (ITPM) | Army (PA&E) | Estimate operations and maintenance funding needs for individual training; does not include military manpower costs |
| Enlisted Personnel Inventory, Cost, and Compensation (EPICC) Model | ODCSPER | Compute budget impacts of personnel policy changes for active Army; not used or maintained |
| The Army Force Cost System (TAFCS) | CEAC | Estimate total LCC manpower and equipment of Army deployable units; manpower costs are based on AMCOS |

*Notes:* ASA(FM) = Assistant Secretary of the Army (Financial Management); ODCSPER = Office of the Deputy Chief of Staff for Personnel; OCAR = Office of the Chief, Army Reserve; NGB = National Guard Bureau; CEAC = Army Cost and Economic Analysis Center; PA&E = Plans, Analysis, and Evaluation; AC = active component; RC = reserve component; USAR = US Army Reserve; ARNG = Army National Guard.

In addition to the three purposes mentioned above, portions of the manpower costing models also are specific to the three categories of Army personnel – AC military, RC military, and Army civilians. Each of these categories has, to some extent, unique cost factors and processing requirements. In fact, the AMCOS family of models consists of three completely separate models – one for each personnel category.

We have classified the models reviewed[1] by purpose and by the category of personnel they address. Table 2-2 illustrates the result.

**Table 2-2. Classification of Manpower Costing Models**

| | Use of model | | |
|---|---|---|---|
| **Personnel category** | **Budget/program preparation** | **Budget/program analysis** | **Life-cycle cost estimation** |
| **Active** | MPA | Put-and-take AMCOS (active) | AMCOS (active) |
| **Reserve** | NGBPA RPA | AMCOS (reserve) | AMCOS (reserve) |
| **Civilian** | CMORE | AMCOS (civilian) | AMCOS (civilian) |

# BUDGET/PROGRAM PREPARATION

The Planning, Programming, Budgeting, and Execution System (PPBES) process requires time-phased allocations of resources from constrained budget totals to support manpower requirements. Since resource allocations directly support expenditures of public funds, they must be submitted in special formats with budget-level detail.

Budgets detail the planned financial obligations for the upcoming and subsequent fiscal years. Budgets show how Federal agencies plan to obligate funds that will be specifically authorized and appropriated. Budgets categorize these planned obligations in formats (e.g., by "object classification") used by the Office of Management and Budget (OMB) to prepare the Government's combined Federal budget.

[1]Of the 12 models examined, 4 were not included in our review because they were not manpower cost models *per se* or not used at HQDA. These 4 models are discussed in the "Other Models Reviewed" section.

As a class, budget models provide greater detail than do LCC estimating models. For example, CMORE, a budget model, can compartmentalize data according to program element, resource type, operating agency, civilian employee type, and expense type. The personnel profiles used in budget models reflect very recent history and are adjusted for the horizon of the budget projections. These models support the development of budgets that have precisely defined categories and detail.

Budget preparation models are also used to make estimates for the multiple years of the Future Years Defense Program (FYDP). These estimates extend considerably beyond 2 budget years to address the Army Program but are made at a more aggregate level.

Requirements to manage the actual monetary amounts that are spent in a given time period (often 1 year) demand that budget models frequently update detailed personnel profiles and use nondiscounted cost data to support the preparation or modification of budget documents.

## MILITARY PERSONNEL, ARMY FINANCIAL MANAGEMENT SYSTEM

The MPA model is used by the ASA(FM) and the ODCSPER to prepare the MPA portions of the Army budget submissions. The model resides on the mainframe computers at HQDA as a shared user system within the HQDA Decision Support System (DSS). Budget analysts use MPA and supporting data bases to evaluate potential resource impacts of variations in manpower programs. MPA outputs become a financial plan for the compensation of active duty members of the approved Army force structure. Officer and enlisted personnel inventory models are run to provide detailed manpower authorizations from such an approved structure. The MPA model multiplies these personnel profiles by cost factors originating from the Defense Finance and Accounting Service (DFAS) [formerly the U.S. Army Finance and Accounting Center (USAFAC)] military pay tables, and previous years' expenditures to develop "activities" of the MPA budget. Those activities are categories of military compensation for the approved force, such as military pay and allowances for officers, enlisted personnel and cadets; subsistence of enlisted personnel; permanent change of station (PCS) travel expenses; and other military personnel costs. Specific categories in each activity provide detailed cost breakouts. For example, within the officer pay and allowance activity there are 11 accounts, such as basic pay, incentive pay, and Social Security. The MPA model constructs a preliminary budget and allows analysts

to include justification statements to complete the budget submission. The MPA model is being enhanced to improve its automated interfaces, to extend its review and analysis capabilities, and to develop a personal computer (PC) version.

## RESERVE PERSONNEL, ARMY BUDGET FORMULATION MODULE

The RPA model, formally the RPA Budget Formulation Module, is used by the OCAR to prepare 8-year budget and program estimates for Army reserve military personnel. It was developed as a mainframe model and is a component of the HQDA DSS. Model inputs include detailed personnel profiles of historical, current, and projected strengths; budget requirements and constraints; and cost accounting factors from DFAS and previous years' expenditures. Major command (MACOM) submissions are used to modify data bases and reflect changes for future budgets. The RPA model allows some analyses of budget alternatives before finalizing budget estimates. Its outputs are RPA budgets for the next 8 years, the first two of which become part of the President's budget submission to Congress.

## RESERVE COMPONENT FINANCIAL MANAGEMENT SYSTEM NATIONAL GUARD BUREAU PERSONNEL, ARMY MODEL

The NGBPA model is used by the National Guard Bureau (NGB) to develop and analyze cost projections for alternative National Guard military personnel strengths profiles and to generate the NGB portion of the budget. Past years' personnel data stored in the NGBPA data base is used to create detailed projections of NGB manpower that reflect expected personnel policy decisions. The estimated costs of those strength projections become tentative NGB budget submissions. If the submissions meet Guard criteria and satisfy Army budget constraints, they are approved and integrated into the Army budget as the NGB military manpower submission. If not, the NGBPA model may be used to examine alternative strength and cost profiles. The NGBPA model and the RPA model were initially developed as a single model but are now separately maintained. NGB has contracted for NGBPA model enhancements, which include creating a PC-based version in 1992.

### CIVILIAN MANPOWER OBLIGATIONS AND RESOURCES DECISION SUPPORT SYSTEM

The CMORE DSS model is used by the ASA(FM) and ODCSPER to prepare the civilian manpower portions of the Army budget submissions. The model resides on the mainframe computers as a shared user system within HQDA DSS. Budget analysts in operating agencies, in MACOMs, and throughout the Army use the model to estimate the cost of the DA foreign and domestic civilian structure. The CMORE DSS model receives detailed inputs from a master inventory data base of civilian personnel and work-year authorizations and applies input cost factors to develop civilian budget entries. CMORE is user friendly, with menu-driven modules for analysts to review and evaluate data, rates, and costs. The model provides cost information outputs in budget format and also as input to other HQDA DSS models.

## BUDGET AND PROGRAM ANALYSIS

A budget and program analysis model, as distinct from a budget preparation model, performs marginal analyses and adjustments to an already prepared budget or program. This is often called for when execution of the budget differs from original estimates. Budget analysis models use aggregated inputs from budgets or LCC estimates and provide outputs at aggregated levels.

### PUT-AND-TAKE MODEL

The put-and-take model is organized as a Lotus 1-2-3 spreadsheet to make marginal adjustments to the MPA budget projections for the current fiscal year as the manpower expenditures occur and are reported. ODCSPER analysts use the model to estimate MPA costs for "what if" questions, such as changes to the force structure. The put-and-take model inputs are the MPA cost factors shown in the annual *MPA Justification* book, with some combinations for analyses.

The model produces two tables of cost-per-man-year factors by grade for officers and enlisted personnel. The put-and-take rates represent the marginal impacts that changes in the force structure have on the budget. These rates contain the MPA cost elements that vary directly with changes in the number of personnel, such as basic pay, retirement pay accrual, basic allowance for quarters (BAQ), variable housing allowance (VHA), basic allowance for subsistence (BAS), Social Security, and some minor miscellaneous costs (e.g., unemployment compensation). The put-and-take rates

are used by the ASA(FM) to adjust the MPA budget for the remaining portion of a fiscal year as the actual costs to date are reported.

The composite standard (CS) rates include the cost elements used in the put-and-take rates plus special pays (e.g., medical personnel, hazardous duty) and other benefits and allowances (e.g., cost of living allowance, separation costs). The CS rates represent the full MPA costs per man-year by grade. They are used to evaluate policy changes and business costs such as foreign military sales.

### ARMY MANPOWER COST SYSTEM FAMILY OF MODELS

The AMCOS family of models can be used for budget analysis purposes by selecting the appropriate logic switches and choosing the appropriate set of inputs. In this mode, AMCOS allows repaid analysis of alternatives or adjustments to manpower cost estimates of a specific Army component. It augments, but cannot replace, the more detailed budget preparation models. This family of models is described below in the LCC models section. LCC modeling is the primary function the AMCOS models were designed to perform.

## LIFE-CYCLE COST ESTIMATION

The DoD weapons acquisition process requires that the LCC of a new system be reported in the milestone review process used during an acquisition decision. The LCC estimates prepared for weapons acquisition are in formats prescribed by the OSD. LCC models show the full resource impacts of various alternative approaches for acquiring new weapons. Weapons-related manpower costs are one component of that LCC. These manpower costs (the personnel costs of manning and supporting the equipment) are closely associated with the acquisition process of the individual weapon system and cannot be derived directly from the set of resource categories used to prepare the FYDP and the budget.

Life-cycle cost estimating models developed to support decision making on weapon systems can also assist in analyzing force structure alternatives. These force planning exercises require at least marginal manpower cost estimates to analyze alternative force sizes and dispositions. Such costs are usually aggregates from PPBES and weapons acquisition process estimates and are formatted to meet specific study needs.

These requirements typically force LCC models to examine a longer time horizon than budget models (e.g., 10 to 20 years versus 1 to 5 years), include discounting to allow expenditures in different

years to be compared, and sometimes include the value of resources expressed as nondollar expenditures, such as in-kind housing. Because of the uncertainties of projecting so many years ahead, LCC estimating models use representative personnel profiles and expected value cost data. These inputs do not allow budget level detail outputs.

### ARMY MANPOWER COST SYSTEM FAMILY OF MODELS

The AMCOS is a family of three PC-based LCC estimating models used by CEAC and other Army cost analysts for a variety of purposes. The three AMCOS models correspond to the active, reserve/guard, and civilian components. Data bases within AMCOS contain personnel costs identified by grade, military occupation specialty (MOS), and cost category (base pay, training, specialty pay, PCS costs, etc.). Analysts can activate the desired mix of costs. AMCOS requires the input of a force structure and identification of the personnel composition of each unit within the force. It then calculates the personnel cost over a 30-year life-cycle by matching appropriate costs with the MOS and grade structure input by the analyst. Model results are portrayed as a total LCC, or yearly portions of the LCC, and are displayed by different cost categories.

## OTHER MODELS REVIEWED

Four other models were reviewed but dismissed as candidates for further analysis. These models are described briefly below along with the reasons for their dismissal. They are also described in more detail in Appendix A.

### ENLISTED PERSONNEL INVENTORY, COST, AND COMPENSATION MODEL

The EPICC model was designed by the Army Research Institute (ARI) to assess the interactions of costs, personnel structure inventories, and policy decisions over a period of time. It allows an analyst to estimate how personnel policy changes affect personnel strengths and the MPA budget. This special-purpose model requires baseline data on retention rates, personnel inventories, and policy changes. AMCOS default conditions for "all Army" personnel costs, such as the percentage of Army members receiving BAQ or the percentage with dependents, are also input as cost assumptions. Interactions of personnel structures and personnel compensation levels are programmed into the model, but users can modify scenarios. EPICC outputs offer unique information on interaction

effects of personnel policies. However, EPICC is neither currently used nor maintained by members of the Army staff. Therefore, it was dismissed from further evaluation.

## INDIVIDUAL TRAINING PREDICTIVE MODEL

The ITPM is used by HQDA offices to estimate the impact of force structure and Army end-strength changes on the individual training portion of the Operations and Maintenance, Army (OMA) budget. This PC-based model draws inputs from several sources including the Army Training Requirements and Resources System, Personnel Structure and Composition System, MOS Level System, and Army guidelines for future force structures. ITPM uses these inputs to create an internal data base of training loads, alternative force structure projections for the budget and the program objective memorandum (POM) years, detailed grade and MOS levels, historical obligation data, and current cost estimating relationships. An ITPM user can create alternative force structures and new MOS inventories, which the ITPM can translate into new training requirements. The ITPM can then be used to estimate the costs of these training requirements and their impacts on the individual training OMA budget. Thus, the ITPM model provides linkages between among structure changes, training requirements, and training budgets.

The ITPM is not a *manpower costing model.* It is an *operating and maintenance (O&M) training cost* model and excludes military personnel costs; therefore, it was not evaluated further.

## WEST POINT MODEL

The West Point model is a loose collection of rates and algorithms used and developed by a small cell of analysts at the U.S. Military Academy at West Point. Although the West Point model is not formally documented, it was reviewed because it serves to provide the Army Deputy Chief of Staff, Personnel (DCSPER) a manpower costing modeling source independent of CEAC-based models. Cost factors come from the standard compensation and pay rate tables at the DFAS. The organization and usage of cost factors and personnel inventory projections are developed on an ad hoc basis tailored to specific analytical questions. Outputs are designed to respond to the needs of the task originator. A formal model development effort has not been pursued, no documentation is available, and no development costs are identified. Therefore, since it is not a fully developed model, it was dismissed from further evaluation.

## THE ARMY FORCE COST SYSTEM

The TAFCS is a system of models and data bases used by CEAC and others to estimate the total costs of force structure alternatives. It has three basic components: costing factors, a data base of force structure and personnel composition, and a data base of force structure equipment. TAFCS's is menu driven and guides the user through analysis steps. Users begin by specifying a force to be analyzed from available Standard Requirement Codes (SRCs) and division files. The user may modify the personnel composition of the force or combine ACs and RCs into a single force element. TAFCS then calculates the manpower and equipment costs of the specified force structure. TAFC's manpower costs are developed using factors derived from AMCOS. Therefore, we did not separately review TAFCS as a manpower costing model.

# CHAPTER 3

# EVALUATION OF MANPOWER COSTING MODELS

Our evaluation of the set of 8 manpower costing models concentrates on the following questions: (1) Does this set of models cover the manpower costing jobs needed by the HQDA staff? (2) Is the set duplicative? (3) Are users satisfied with their results? and (4) Do they use common data sources?

## MODEL COVERAGE

We have shown in Table 2-2 that models do exist to process each of the manpower cost estimating jobs required in the HQDA. For each personnel category – active, reserve, civilian – there is a budget preparation model, a budget analysis model, and an LCC estimation model available. For example, the MPA model is available to do active Army budget preparation. To fulfill the Army's needs, these models not only have to exist, but they also have to cover all appropriate cost elements necessary for each particular use. The next section discusses these cost elements and their coverage in the current set of models.

### DUPLICATION

Logically, it does not seem economical to have more than one model performing the same function. As Table 2-2 shows, only in two cases is there actual duplication. The first is between the put-and-take and AMCOS (active) models, each of which can be used for budget analysis of active manpower. In this case, the uses – particularly the outputs – of the models are sufficiently different to justify maintaining both models.

The other case where there is duplication is that of the RPA and NGBPA models. Consolidation appears to be beneficial in this case. The Army appears to have an opportunity to save future software development and maintenance efforts and costs by combining the NGBPA and RPA models. Those models have the

same purpose, format, and intent and perform many of the same functions. Their inputs come from similar detailed manpower data bases, and their outputs produce budget documents for their respective RCs.

The models were originally developed as one model to support both National Guard and reserve forces. Many of their algorithms remain similar. The NGBPA model has been enhanced with an automated "what if" analysis capability which can recompute the budget as changes are made to critical assumptions and manpower inputs. That capability allows the Army to rapidly investigate the effects that changes in one parameter may have on the budget. Similar "what if" analyses require manual adjustments to model processes within the RPA model. Work is under way to move the NGBPA model from a mainframe to a PC environment. That reconfiguration should make the NGBPA model more accessible to analysts, perhaps even down to the state level.

A recombination of the RPA and NGBPA models would capitalize on those model enhancements already made to the NGBPA model. The models' differences (primarily in the number of manpower categories and reporting formats) may be worth overcoming in order to save future maintenance and enhancement costs. The Army should evaluate the desirability of this action.

## COST ELEMENTS

Within each specific analysis, cost elements are the individual components of compensation included in a calculation of total manpower compensation. The appropriate cost elements will differ based on the purpose and personnel category that the model analyzes.

Both the active and reserve/guard manpower cost elements include military compensation, special pays, enlisted recruiting, officer acquisition, training, re-enlistment bonuses, retired pay accrual, medical support, and other costs. But that's where the similarity in costing methodology and modeling ends. Beyond these elements there are numerous differences in the manner in which active and reserve/guard manpower analysts generate cost.

Military pay factors for reserve/guard forces are based on 14 or 15 days of active-duty training plus 48 days of paid drills at the local unit. This equals about one-fifth of the pay of full-time active duty members (based on a 360-day year). Reservists do not get PCS travel or VHA unless they are on active duty. The structure and costs for recruiting and training activities are substantially

different between active duty and the reserve/guard forces as are the detailed rules governing other personnel benefits such as educational assistance and special pays.

Civilian manpower cost elements differ from those used in costing military manpower. Civilian pay grades, retirement plans, life and health insurance programs, and other benefits have unique rules and costs requiring their own costing methodology.

Our examination of the current set of models shows that each model uses the set of cost elements that is appropriate to its purpose and manpower category.

### ASSESSMENT

Our assessment is that the current set of models, taken as a whole, covers the purposes and manpower categories required by HQDA analysts. Furthermore, the cost elements included in each model are appropriate for analysis within the model's subject areas. Of the two cases in which duplication occurs, only the RPA and NGBPA models appear as if they could benefit from consolidation.

## USER SATISFACTION

We have shown that models exist to do the necessary manpower cost analysis jobs in HQDA. The next evaluation question is "do they do those jobs well?" One key indicator that helps answer this question is user satisfaction. This indicator is evaluated below.

### USER CONFIDENCE

Users report a high degree of confidence and satisfaction with this current set of models. The budget preparation models, the MPA, RPA, NGBPA, and CMORE models, are well accepted and are used to prepare the personnel cost portions of the President's biennial budget estimates submitted to Congress. The budget analysis model in current use is the put-and-take model. It works with the MPA budget figures to calculate marginal adjustments between runs of the MPA model. These adjustments are accepted by HQDA.

In Appendix B, we demonstrate that AMCOS (active) can provide budget estimates within 5 percent of the put-and-take model estimates. The budget modules of the three AMCOS personnel components are not yet widely used for budget analysis. Our discussions with Army budget analysts indicated that many of them were not familiar with AMCOS and were likely not aware that

AMCOS can perform limited budget analysis to match those of the put-and-take model.

The three LCC models of the AMCOS family enjoy wide acceptance. In the spring of 1991, CEAC conducted a user survey of the AMCOS models that indicated the AMCOS LCC models were being used by cost analysts throughout the Army. CEAC has used AMCOS to prepare cost estimates for HQDA, and these estimates have been used in the weapon system acquisition process.

## EASE OF USE AND UNDERSTANDING

Other determinants of user satisfaction include ease of use and understanding. Manpower models differ greatly in their ease of use. The budget development models require notably greater times to set up and prepare than the LCC estimation models. MPA and NGBPA, as examples, require very detailed personnel profiles to represent the approved force structure over the period of budget estimation. Once these personnel profiles are coordinated and approved, the costing of the manpower structure is a straight-forward application of the model. The budget analyst may adjust the timing of changes to the personnel structure, but he or she can make few adjustments to cost factors once they are updated and approved for the biennial budget estimate. These cost factors remain stable, and the models are rerun with different personnel structures to examine budget alternatives. The budget models thus have a long set-up process but a short run time. As budget models are used repetitively for similar analyses, the model operating procedures are easy to use and understand.

Life-cycle cost models, on the other hand, often involve changes to the cost element structure over time as well as to the personnel structure. LCC estimation models must include more appropriation categories than budget models and still be easy to operate. These models, typified by all of the models in the AMCOS family, may take inputs from menu selections. The use of menus makes the AMCOS LCC estimation models easy to set up and run but limits the set of options available to the model.

## ASSESSMENT

Users are satisfied with their models. We found, however, that a rigorous quality control and assurance program such as V&V had not been performed. The closest approximation to V&V was an independent technical review performed on the AMCOS prototype in 1986. V&V would identify some model anomalies that go undetected until discovered by a user during a model application.

This early detection of faults through V&V should increase user confidence in models, especially those of recent development that do not have a long history of use.

## USE OF COMMON DATA SOURCES

In evaluating the manpower costing models as a set, an important issue is the extent to which they use common data sources. Many of the cost elements that the manpower costing models have in common are found in the DFAS data bases. This data source is identified in model documentation for the MPA and AMCOS models. In addition, the put-and-take model and the AMCOS models cite widespread use of data from budget justification books. Variations often occur in weighting factors (such as the fraction of personnel to receive special pays and allocations) or personnel profiles (NGBPA selects the historical profile which is the closest available match to the profile suggested by future personnel policies) used by each model. The variations we observed in weighting factors can make differences in cost estimates. Valid reasons for differences in these factors (historical view vs. projection; Army average vs. Army subset with special characteristics) may exist, but the basic data on elements such as basic pay, subsistence, BAQ, etc., should be consistent from model to model.

We found that several offices [DFAS, ASA(FM), OMB] independently develop cost factors. This situation could lead to a model at one location using different cost factors for the same basic data than a model at another location. Discussions with representatives of the ASA(FM) indicated that they supported the concept of a joint review of cost data and factors, perhaps by CEAC and ASA(FM), to ensure that the data and factors are consistent with user needs.

The OCAR has taken steps to establish one sole-source data base for OCAR analysts. OCAR recognized the potential for problems when analysts extracted data from several sources outside OCAR. Thus, data have been brought under the control of one data manager within OCAR. This single, internal source organizes data by functional area (operations, personnel, resource management, etc.) and makes them available through a local area network to all analysts in OCAR.

## ASSESSMENT

In those cases where models use the same cost elements, there should be one source of the common cost elements. It is not clear to what extent a single source of all manpower cost data would be practical for the entire set of models and the entire set of users. To the extent that it is practical, it could simplify the data update process. Further analysis of this issue would be necessary before proceeding with management action.

# CONCLUSIONS

***The current set of models meets HQDA's needs for budget preparation and analysis and LCC estimation.***

Our review of manpower costing models and modeling show that the current set of models covers the three purposes and the three manpower categories that are of interest to the HQDA staff. In addition, there is high user satisfaction. Budget development models have high user confidence as evidenced by their use in preparation of published budget estimates. The family of AMCOS LCC estimation models also has high confidence among its users. Its budget analysis modules are not yet widely used, in part, because their capabilities are not well known by HQDA budget analysts.

***Some improvements can be made to the current set of models.***

We found the models generally easy to use and understand.

We identified two initiatives that can be undertaken to improve the current set of models.

- We found that the RPA and NGBPA models both perform the budget preparation function for reserve military manpower. We concluded that reconsolidation of these two models (they were a combined model at one time) could provide advantages in reduced annual model sustainment costs and, perhaps more importantly, an improved analytical capability for the Office of the Chief, Army Reserve.
- The models we reviewed have not had the benefit of a rigorous quality control and assurance program, such as V&V. We conclude that V&V would improve the current set of models by identifying faulty algorithms, incorrect uses of data, and documentation shortfalls.

- The DFAS data bases contain cost elements which are used differently by the several models investigated. The models often apply different weighting factors to these basic elements. Additional investigation is required to assess the desirability and practicality of establishing a sole source of manpower cost data.

# CHAPTER 4

# SINGLE, MULTIPURPOSE MODEL

## INTRODUCTION

To justify the development of a single, multipurpose model for manpower costing in the HQDA, that model would have to either (1) improve the functional quality of the manpower estimates over those currently produced or (2) be less costly than the current set of models.

Because the current set of models allows analysis and budget/program preparation to the satisfaction of HQDA users, the development of a single model would have to be justified on a cost-saving basis. A single model would probably be expensive to develop. Its sustainment costs would not be much less than the total sustainment costs of the models investigated. Nonetheless, to examine this issue more fully, we analyzed the case for a single model and describe its characteristics in this chapter. In Appendix C, we present a possible architecture for a single model.

## IMPROVEMENTS IN QUALITY

A single model would improve the quality of manpower costing modeling if it provided more consistent results, improved application efficiency, or increased the scope for analysis. In this section, we examine these and other issues to bring to light what specific quality improvements might reasonably be expected from a single model.

### CONSISTENCY OF RESULTS

Consistency has several components. A model is consistent if it replicates results, that is, it provides the same estimate when used again and again to answer the same question. A model is also consistent if two trained analysts can use it to produce the same cost estimate. Lastly, two different cost models are consistent if they produce the same cost estimate when examining the same cost question. A potential hazard of multiple models is that different

analysts using different models may obtain different answers to the same question. If these discrepancies are not resolved or explained, they could indicate that the Army has used a flawed model for manpower cost estimating.

In practical terms, most of the current models address different manpower cost needs (e.g., different manpower categories or budget development vs. LCC estimation), and inconsistent results between models is not an issue.

We did not identify any specific examples of different models producing different answers to the same question. But, anecdotal evidence suggests that the potential exists for differences that cannot be resolved. In Appendix B, we examine the use of the put-and-take and the AMCOS (active) models to estimate annual manpower costs for a hypothetical 1,000-man force in the AC. Our examination revealed that differences in areas such as assumed force mix, weighting factors (for allowances, special pays, and benefits), dollar years, amortization rules, and cost elements could potentially lead to different manpower cost estimates. For a specific example detailed in Appendix B, we found that the put-and-take model provided an overall estimate that was about 4 percent higher than AMCOS after normalizing for the same budget year. To the extent that such inconsistency is a result of different input data, moving to a single source for input data would be effective in eliminating inconsistencies.

Establishing a single cost model has been suggested as a method of reducing the potential for inconsistency, but its use would not guarantee consistent results. For the single model to be viable, it must have numerous logic switches that allow a user to tailor the model for various applications. If a cost question is not well formulated, two analysts might tailor the model differently. For instance, they may choose to include different cost elements or they may estimate some parameters differently. (One analyst might use an average based on recent history; another might modify that value in response to changes in Army policy or statutory guidance.)

In summary, we find that consistency of model output is more a function of consistency in model input and consistency between analysts in formulating a cost analysis than a function of the models themselves. A single model approach does not offer any significant advantages in terms of obtaining consistent results, nor has this been raised as a problem by HQDA users.

## APPLICATION EFFICIENCY

We found few opportunities for the proposed single model to improve the efficiency of cost analysis. One opportunity is to automate model interfaces. For example, AMCOS now uses results from the MPA model for some cost factors. These MPA values are manually keyed into the AMCOS model. In the single model, that link could be automated. While such a link may be conceptually attractive and could reduce the potential for errors, we would not expect significant savings – the amount of labor needed to retype the data today appears to be less than 1 analyst-week a year.

The single, multipurpose model that includes the functionality of all budget and LCC models would necessarily be larger and slower than the largest current individual model. An analyst using the put-and-take model would have to enter the larger composite model each time he performed his task. That would be cumbersome.

## SCOPE OF ANALYSIS

The single cost model would, by definition, include all manpower categories and cost elements contained in the current models. Because its scope is greater than any one of the existing models, the single model could address broader questions. For example, it could consider a cost question that involves a combination of personnel from different components. With the current models, one model would have to be run for each component and then the results would have to be summed. The single, multipurpose model could automate the combinations.

But the utility of the broader scope is questionable. The users of the current models indicated satisfaction with the scope of their models. Adding capability to handle other types of manpower or a different aggregation of detailed cost elements would not help them perform their cost analysis tasks. Of course, other potential users in the Army might find the broader scope of the single model to be useful, but such users have not yet been identified.

## OTHER CONSIDERATIONS

### *Hardware Requirements*

Several models are currently hosted on mainframe computers. Two of these, MPA and NGBPA, are being converted to operate in a PC environment. Given the continuing growth in PC technology, it might be possible to implement the new single model on an advanced PC. However, many users may not be able to run the

model with their current PC systems. From the perspective of the agencies currently using the separate models, the new single model would require them to invest in new hardware to support extra model capabilities that do not serve any of their current needs.

### *Configuration Control*

As there is only a small amount of duplication among the current models, configuration control for the single model would not solve any identified problem. The single model itself would have to be the formal responsibility of one agency. To ensure that the single model continues to serve the needs of other Army agencies, the controlling agency would have to deal with the configuration concerns of the other agencies. A single model might introduce configuration control issues among agencies and not solve a currently identified problem.

## SUMMARY OF ADVANTAGES AND DISADVANTAGES

We find that most of the potential quality advantages of a single, multipurpose model would not be realized to a significant degree for two primary reasons. First, the models we examined were designed for different applications and have little overlap. Hence, combining the models (either their functions or their codes) does not offer significant improvements in consistency or application efficiencies.

Second, the primary users of the current models have little or no use for the capabilities of the other models. The different categories of manpower are the responsibility of different offices. The current models were developed to satisfy specific functional needs of different Department of the Army agencies. Hence, combining the models does not provide any practical increases in the scope of analysis.

Additionally, difficulties in upgrading hardware and in configuration control of a centralized model would likely decrease user acceptance of a single model. On balance, the advantages are small and could easily be outweighed by the disadvantages.

# COST SAVINGS

The argument for a single model would seem to rest on it being less costly than the current set of models. Let us first look at the cost of the current models and then try to estimate where savings might occur with a single model.

Let's begin by looking at operating costs. For the current set of models, we divide operating costs into sustainment and recurring

development costs. Sustainment costs allow the model to operate with refreshed, updated data and software that is free of "bugs." These expenditures maintain the model at operating efficiency without adding features or functionality. Recurring development costs are used to improve and upgrade the model and may include the cost of new or improved features, analytical modules, or modifications to accommodate new computer hardware. Fiscal year 1992 costs for sustainment and recurring development of the manpower costing models are summarized in Table 4-1.

**Table 4-1. FY92 Contract Expenditures for Manpower Cost Models ($000s)**

| Model | Sustainment cost | Recurring development cost | Total cost |
|---|---|---|---|
| MPA | 180 | 320 | 500 |
| RPA | 80 | NA | 80 |
| NGBPA | 30 | 260 | 290 |
| CMORE | 120 | 460 | 580 |
| Put-and-take | 0 | 0 | 0 |
| AMCOS active<br>AMCOS reserve<br>AMCOS civilian | 50 | 0 | 50 |
| Total | 460 | 1,040 | 1,500 |

The data in Table 4-1 suggest an annual contract cost of $1.5 million (in-house costs are not included). To test the plausibility of this estimate, we looked in detail at the annual sustainment costs of the two most expensive models in the table, MPA and CMORE, and found that the FY92 costs are in the range of sustainment costs for the past 5 or so years and could thus be taken as "typical" annual costs. In addition, there is no clear trend, up or down, in the yearly data.

Because a single model would have significant sustainment and recurring development costs of its own, any sustainment cost savings would be outweighed by the initial development costs for a single multipurpose model as discussed below.

The other category of model costs is initial development costs. This expense can be substantial. Because the initial development costs are already paid for in the current set of models, any initial development cost for the new single model would have to be offset by enough annual cost savings to make an economic argument for a single model. To get an idea of what these initial development costs might be, we display the initial development costs of several recently developed models in Table 4-2. A single model encompassing all the functions of the current set would probably have an initial development cost significantly greater than any one of the current models. On the other hand, it might be possible to build on many of the algorithms previously developed for the individual models and reduce the cost of developing a single model.

**Table 4-2. Model Development Costs**

| |
|---|
| **NGBPA.** Costs for the NGBPA model development were about $1,500 thousand over a 3-year period from FY88 through FY90. The original model was a reserve and guard model. Further development of the model for the National Guard will move it from a mainframe to a PC environment at a contract cost of $260 thousand in FY92. |
| **AMCOS.** The three AMCOS models were developed under a contract for $1,629 thousand. Development effort was completed in FY92. Recurring development effort, if any, has yet to be defined. |
| **ITPM.** The ITPM was developed under a $476 thousand FY89 contract. |
| **EPICC.** This model was developed over a 4-year period from FY89 through FY92 at a total contract cost of $700 thousand. |
| **TAFCS.** TAFCS was developed over a 4-year period at a cost of between $700 thousand and $800 thousand per year. Development is still under way. Maintenance costs are estimated at less than $250 thousand per year, but this figure includes additional enhancements. The TAFCS contract is currently being renegotiated, and development and sustainment costs for the future are uncertain. |

# CONCLUSION

***A single multipurpose model will produce no significant quality or cost advantage.***

We have examined the prospects for increases in quality stemming from the establishment of a single model and found that little potential exists for any breakthroughs in this arena. Combining the models does not lead to greater consistency or application efficiencies, nor would it provide practical increases in the scope of

analysis. Furthermore, hardware changes and configuration requirements would reduce user acceptance. We also have examined the economic aspects of developing a new model and found that potential cost savings are minimal, at best. Annual costs of such an ambitious model are likely to approach the costs currently borne to sustain the present set of models (about $1.5 million in FY92 for contractor costs alone). Furthermore, initial development costs are likely to be so great that any minor savings in annual sustainment costs will be overwhelmed.

# CHAPTER 5

# RECOMMENDATIONS

Manpower cost models currently used within HQDA meet requirements for budget preparation, analysis, and estimation of LCC. Users indicated satisfaction with their current modeling capabilities. Our recommendations, therefore, address specific questions regarding development of a single, multipurpose model and identification of areas where improvements in current capabilities can be realized.

- ***It has been suggested that a single manpower costing model be developed. We recommend the Army not develop such a model and continue to use existing manpower models.*** We conclude there would be no significant functional quality or cost advantages to support such a development. Quality gains are doubtful: users are satisfied with their current capabilities; no significant new analytical capabilities would be introduced by a larger model; and, in all likelihood, a single composite model would not be easier to use than those in the current model set. Costs to sustain a large, single model would probably be only slightly less than the costs to sustain the current set, and initial development costs would far outweigh any of these savings.

- ***The Army should explore the consolidation of the RPA and NGBPA models.*** Both the Army Reserve and the NGB have similar personnel structures and budget reporting requirements, and the OCAR and the NGB once used a common model. However, the NGB has since enhanced its capabilities, and two different models are now in use. An upgraded consolidated model would serve two purposes: It would reduce overall sustainment costs for the current set of two models, and it would improve the OCAR's analytical capabilities.

- ***The Army should conduct a V&V program on its manpower costing models to ensure quality control.*** We found that V&V has not been performed for the current set of models. V&V would identify errors in model logic, spot uses of incorrect data, and identify documentation shortfalls.

# APPENDIX A

# MODEL DESCRIPTIONS

## DESCRIPTIONS OF BUDGET MODELS

- Military Personnel, Army (MPA) Financial Management System
- Reserve Personnel, Army (RPA) Budget Formulation Module
- National Guard Bureau Personnel, Army (NGBPA) model (Reserve Component Financial Management System)
- Civilian Manpower Obligations and Resources Decision Support System (CMORE DSS)
- Put-and-take model

## DESCRIPTIONS OF LIFE-CYCLE COST MODELS

- Army Manpower Cost System (AMCOS)

## DESCRIPTIONS OF OTHER MODELS EXAMINED

- Enlisted Personnel Inventory, Cost, and Compensation (EPICC) Model
- Individual Training Predictive Model (ITPM)
- The Army Force Cost System (TAFCS)

# MPA FINANCIAL MANAGEMENT SYSTEM

## OBJECTIVE

The objective is to prepare the MPA portion of the Army budget with appropriate justification of budget levels and resource requirements.

## USERS

Users include HQDA, ODCSPER and ASA (FM).

## DEVELOPER/MOST RECENT UPDATE

The system was developed by General Research Corporation (GRC)/1991. It is currently being enhanced.

## HARDWARE/SOFTWARE REQUIREMENTS

The model requires HQDADSS and ODCSPER mainframes in the VM/CMS environment, IBM\-compatible PC's with MS-DOS for interface and system "W" software, as well as software for numerous input models and systems.

## DATA INPUT REQUIREMENTS/SOURCES

The MPA model requires extensive preprocessing to match force structure authorizations with personnel profiles. The MPA model uses these supporting models:

- FAARRS-SHARE – recruiting budget allocations
- TTHS – training and transients accounts
- MOSLS – MOS level personnel inventory and structure
- ULS – unit level turbulence model matching inventories and strengths
- PAM – personnel authorizations manning document
- ELIM/COMPLIP – enlisted and officer inventory projections
- Training, recruitment, retention, and master file data through the above models
- Approved personnel cost factors at MOS/Grade detail.

## OUTPUTS

The outputs include specific costs by categories of the Army personnel budget. Costs are identified in one of six activities. These activities are officer pay and allowances, enlisted pay and allowances, cadet pay and allowances, PCS travel, enlisted subsistence, and other military personnel costs. Each activity has outputs in numerous categories. Officer pay and allowances has 11 categories which include base pay, BAQ, BAS, VHA, etc. Enlisted pay has 13 categories.

## METHODOLOGY

Analysts within ODCSPER use several personnel planning models to develop an approved Army force structure. This structure becomes the MPA model input force. The MPA model uses personnel cost factors to develop the cost of this input force. The MPA model calculates military pay by category, including base pay, PCS costs, clothing, VHA, etc. The MPA model integrates authorizations, individual costs, structure, and projections to help develop the budget estimates and justification narrative.

## USER PROCEDURES

Budget analysts coordinate with personnel analysts to fix inputs to the MPA model. The MPA model is executed with coordinated personnel profiles and approved Army cost factors. Outputs are generated for direct input into the MPA budget submission. Users can include textual descriptions of budget activity by completing the justification portion of the budget book.

## ASSESSMENT OF USER FRIENDLINESS

This model is not deemed user friendly, as set-up time is long and detailed knowledge of personnel policies and interactions is required. The MPA model uses the put-and-take model for adjustments to budget figures and to perform "what-if" analyses. MPA enhancements to allow analyses within the model context are planned. Mainframe and PC hookups require HQDA DSS access.

## COST ELEMENTS ADDRESSED

- Training costs – trainee compensation while in a training status is provided.
- Health costs – no.
- Retirement accruals – yes.
- PCS – yes.
- Accession/recruitment – yes.
- MOS/specialty pays or bonuses – yes.
- Military/civilian pays – Military.
- Other services – no.

## MANPOWER QUESTIONS ADDRESSED

- Unit conversions – yes, as reflected in personnel changes
- Redeployments – partially, in manpower PCS costs
- Inactivations – yes, as reflected in personnel changes
- Base closures and realignments – no
- Active/reserve mix – active MPA only
- Budget/program crosswalks – none.

## FY92 CONTRACT COSTS

Sustainment costs are $180 thousand annually; recurring development costs are $320 thousand.

## VERIFICATION AND VALIDATION

There is no evidence that V&V has been conducted.

## OVERALL MODEL ASSESSMENT

The model successfully executes the design task of budget formulation for the MPA appropration. It is not designed as a stand-alone costing model capable of examining "what if" alternatives.

# RESERVE PERSONNEL, ARMY (RPA) BUDGET FORMULATION MODULE

## OBJECTIVE

The objective is to provide a centralized Army reserve data base for projecting 8-year budget estimates for Army reserve military personnel.

## USERS

The OCAR budget branch is the main user.

## DEVELOPER/MOST RECENT UPDATE

The system was developed by American Management Systems, Inc., (AMS)/March 1992.

## HARDWARE/SOFTWARE REQUIREMENTS

The model is run at HQDA on a DSMA IBM mainframe using a VM/CMS operating system. The system requires access to the HQDA DSS interactive network and a special user identification for access. The *Intellect* query system [an Artificial Intelligence (AI) software package] allows tailored user interactions.

## DATA INPUT REQUIREMENTS/SOURCES

The RPA model requires inputs from

(1) Budget requirements, rates, and strength projections from the MACOMs and OCAR divisions

(2) Current strength and accounting factors from DFAS

(3) Budget constraints and rates from OSD and OMB

(4) Historical strength and accounting data.

## OUTPUTS

The model projects the RPA budget in 8-year cycles for the Program Budget Committee, OSD/OMB, and the President's Budget. Model users can modify input data or select increments of the budget output for analysis. Budget, AGR strength, manpower, and pay category tables can be accessed for ad hoc queries.

## METHODOLOGY

The model uses updated data arrays submitted by MACOMs, operating agencies, and OCAR divisions to roll up new OCAR budgets. Analysts compare MACOM submissions with DFAS strength figures and use the model to generate tentative budgets. Analysts adjust strength and cost factors until the model budget output meets OSD-imposed contraints. The algorithms which support this roll up are not apparent to the user, and experience in factor adjustment is needed to make the appropriate model modifications. Some off-line analyses can be performed to determine budget effects of data factor changes.

## USER PROCEDURES

Model users within OCAR modify data bases from hard-copy submissions of MACOMs and other sources to reflect each new year in the budget cycle. Help screens assist manual data entry. The approved President's Budget becomes the starting point for new budget development. A query system allows off-line investigations of budget alternatives. The model output which meets all constraints becomes the OCAR final budget submission.

## ASSESSMENT OF USER FRIENDLINESS

The model comes with a clearly written users manual, numerous help screens, and built-in error indicators. The user can alter data arrays for excursions or alternative explorations but cannot change the model's algorithms or underlying assumptions. Default conditions are identified if the user does not specify appropriate data changes.

## COST ELEMENTS ADDRESSED

- Training costs – trainee compensation while in training status is provided. The total costs of training are not addressed.
- Health costs – no.
- Retirement accruals – yes.
- PCS – yes.
- Accession/recruitment – no.
- MOS/specialty pays or bonuses – yes.

- Military/civilian pays – Military.
- Other services – no.

## MANPOWER QUESTIONS ADDRESSED

- Unit conversions – no between RC/AC; yes within RC
- Redeployments – partial, (reflected in MACOM submissions)
- Inactivations – yes, if included in MACOM submission
- Base closures and realignments – yes, if included in MACOM submission
- Active/reserve mix – reserve only
- Budget/program crosswalks – yes.

## FY92 CONTRACT COSTS

Sustainment costs are $80 thousand; recurring development costs are zero.

## VERIFICATION AND VALIDATION

There is no evidence that V&V has been conducted.

## OVERALL MODEL ASSESSMENT

Although oriented on the Army RC, the methodology is general enough to be applied to active Army, or to other Services. The model could examine AC/RC mix questions if expanded. It has underlying data of pay rates, social security, strength, and disposition that should be common to all manpower costing models. Other data submitted are specific to RC. Help screens and error indicators make the model more user friendly.

# RESERVE COMPONENT FINANCIAL MANAGEMENT SYSTEM (NATIONAL GUARD BUREAU PERSONNEL, ARMY (NGBPA) MODEL)

## OBJECTIVE

The objective is to develop alternative strength projections by National Guard pay groups for analysis and eventual development of the manpower portion of the National Guard Bureau Budget.

## USERS

The National Guard Bureau is the main user.

## DEVELOPER/MOST RECENT UPDATE

This system was developed by General Research Corporation. Mainframe maintenance is ongoing; a PC version is expected by January 1993.

## HARDWARE/SOFTWARE REQUIREMENTS

The model is maintained on a HQDA mainframe containing AMDAHL 5880/5860 processors and IBM 3090 machines at Information Systems Command – Pentagon (ISCP).

## DATA INPUT REQUIREMENTS/SOURCES

The NGBPA model uses extensive inputs, including strength projections by pay group from numerous manpower models (SIDPERS, PERSACS, ATRRS, JUMPS RC, etc.), costing factors, funding constraints, new programs, and policy changes. The financial model is part of the complex Reserve Component Financial Management System.

## OUTPUTS

The model output includes total National Guard budget dollars by categories of base pay, retired pay, training, etc., for budget and program years. As an integral step leading to a hard copy of the NGB budget book, a manpower projection by category is developed for analysis.

## METHODOLOGY

Manpower projections are selected using historical strength data bases and expected policy decisions over the program years. Integration of policy and data bases lead to strength projections by categories of National Guard personnel (accessions, personnel awaiting training, basic trainees, etc.). Strength projections are costed to develop a tentative budget submission by category. If the tentative budget and program projections are feasible and in keeping with other guidance, they are approved and integrated into the OSD budget as the NGB manpower submission.

## USER PROCEDURES

Personnel models which feed the NGBPA model are updated to reflect the most current guidance. Specific historical years are selected as representative of future strength levels under expected personnel policies. The model is run with these inputs and its outputs are compared to funding constraints. If outputs are not acceptable, the analyst changes the model inputs and reruns the model. When an approved model output is produced, it is entered into the OSD budget book as the NGB budget submission.

## ASSESSMENT OF USER FRIENDLINESS

The model provides menu and help screens with acronym definitions to assist new users. These features make the NGBPA model easy to use and understand. However, the process which develops the force strength levels used by the NGBPA as inputs is complex.

## COST ELEMENTS ADDRESSED

- Training costs – pay and allowances of National Guard personnel while in training status
- Health costs – no
- Retirement accruals – no
- PCS – yes
- Accession/recruitment – yes
- MOS/specialty pays or bonuses – yes

- Military/civilian pays – Military
- Other services – no.

## MANPOWER QUESTIONS ADDRESSED

- Unit conversions – no
- Redeployments – no
- Inactivations – yes
- Base closures and realignments – no
- Active/reserve mix – indirectly
- Budget/program crosswalks – yes.

## FY92 CONTRACT COSTS

Sustainment costs are $30 thousand; recurring development costs are $360 thousand.

## VERIFICATION AND VALIDATION

There is no evidence that V&V has been conducted.

## OVERALL MODEL ASSESSMENT

The model itself is a clean application of manpower and costing modules. However, the process of multiple feeder models is laborious and cumbersome. The model presents budget-level detail and also allows "what if" drills to be performed as analytical excursions leading to final budget selection.

## NOTES

Presently, the model is a mainframe application that will be translated into the PC environment during 1992. PC applications could include use by each of the states as a planning and budgeting tool. Discussions with the developer suggest efforts will be made to demonstrate the NGB model features to OCAR for possible realignment of NGBPA and RPA models.

# CIVILIAN MANPOWER OBLIGATIONS AND RESOURCES DECISION SUPPORT SYSTEM (CMORE DSS)

## OBJECTIVE

The objective is to perform budget analyses of civilian manpower.

## USERS

The model is used by approximately 60 resource management decision makers and analysts on the HQDA staff primarily used by OASA(FM) (SAFM-BUOC).

## DEVELOPER/MOST RECENT UPDATE

The model was developed by GRC. The most recent update is the rate/cost generator, March 1992.

## HARDWARE/SOFTWARE REQUIREMENTS

The CMORE model uses interactive and batch support from two mainframes (one at HQDA DSMA and one at U.S. Army ISCP. The model runs on the IBM 3081, Model K64 mainframe with the VM operating system. CMORE requires 2000 megabytes of core memory and uses nine-track tapes for backups of the program and data.

## DATA INPUT REQUIREMENTS/SOURCES

Execution data [strength, workyear (WY), cost]; execution controls (strength); manpower authorizations (strength, WY); rates (pay raises, inflation, health benefits, etc.)

## OUTPUTS

The CMORE model produces a variety of standard reports that can display Army civilian costs by program element, resource type, operating agency, civilian employee type, and expense type. Some examples are:

- Program budget decision unit
- Civilian personnel costs
- Analysis of changes in WY costs

- Foreign national personnel
- Federal employees retirement system costs
- Operation and Maintenance, Army program and financing
- Schedule of civilian and military personnel
- Analysis of pay increase costs
- Summary of requirements by decision unit
- Direct-hire personnel summary
- Civilian personnel budget calculation
- FY19XX civilian pay increases.

## METHODOLOGY

Prior year (PY) and WY data are input from DFAS in the Civilian Manpower Obligations Data (CMOD) reporting system. CMOD approximates onboard strength data using numbers of active pay accounts, which are balanced against ODCSPER onboard strength controls.

The CMORE model has four costing functions. The data analyzer checks input data for validity and consistency. The rate generator develops costing factors based on WY and PY obligations and generates costing factors based on external influences (e.g., inflation, pay raises). The cost generator develops civilian costs using factors from the rate generator and authorized WYs from ODCSPER for the current year (CY), budget years (BYs), and outyears. Also, it will recalculate costs when changes are made to inputs and create an audit trail for the changes.

## USER PROCEDURES

Users enter CMORE and follow menu screens. A particular civilian personnel structure [general schedule (GS) or work grade (WG)] can be examined and tailored while in use. Cost factors can be modified to reflect future projections of pay or economic conditions. Reports are tailored to meet user needs and are organized by the appropriation account affected.

## ASSESSMENT OF USER FRIENDLINESS

Menu-driven modules make the system very user friendly.

## COST ELEMENTS ADDRESSED

- Training costs – no
- Health costs – yes
- Retirement accruals – yes
- PCS – yes
- Accession/recruitment – no
- MOS/specialty pays or bonuses – civilian special pays
- Military/civilian pays – civilian
- Other services – Federal civilian employees.

## MANPOWER QUESTIONS ADDRESSED

- Unit conversions – no
- Redeployments – partially in civilian manpower costs
- Inactivations – yes, as reflected in civilian personnel changes
- Base closures and realignments – yes, as reflected in civilian personnel changes
- Active/reserve mix – no
- Budget/program crosswalks – yes, for civilian compensation.

## FY92 CONTRACT COSTS

Sustainment costs are $120 thousand; recurring development costs are $460 thousand.

## VERIFICATION AND VALIDATION

There is no evidence that a formal V&V has been conducted.

## OVERALL MODEL ASSESSMENT

The model has been accepted and is currently operational.

# PUT-AND-TAKE MODEL

## OBJECTIVE

The objective is to make marginal adjustments to the current fiscal year MPA budget projections as actual manpower expenditures occur and are reported. The model is also used to estimate MPA costs for "what if" questions, such as changed force structures (but not for the transition costs) and foreign military sales.

## USERS

The main user is ASA(FM).

## DEVELOPER/MOST RECENT UPDATE

ASA(FM) developed this model and updated it in early FY92.

## HARDWARE/SOFTWARE REQUIREMENTS

The model is run through the Lotus 1-2-3 spreadsheet on an IBM-compatible PC.

## DATA INPUT REQUIREMENTS/SOURCES

Inputs are MPA cost factors shown in the annual *MPA Justification* book. This model contains the same costs as MPA with some cost categories combined. Inputs are by grade for both officers and enlisted personnel. They include man-years/year, pay, retirement accrual, housing, subsistence, special pays, and miscellaneous pays.

## OUTPUTS

Two tables of factors are produced. The first is titled Composite Standard Rates. This table gives the cost per man-year by grade for officers and enlisted personnel for the following cost categories: basic pay, retired pay accrual, BAQ (including VHA), PCS, special pays, and miscellaneous pays. These costs are used for rapid estimates of the effects of personnel inventory or policy changes. The second table is the put-and-take rates. This table contains rate factors (costs per man-year) for basic pay, retired pay accrual, BAQ, VHA, BAS, and FICA. These rates are used to adjust the MPA budget for the remaining portion of a fiscal year as the actual costs to date are reported.

## METHODOLOGY

The user first updates the model by entering inputs from the most recent *MPA Justification* book. Some inputs are by grade and are entered in that form. Others are totals across all grades, and these inputs are allocated to various grades in proportion to the manpower levels in the grades. Various inputs are aggregated into categories and then divided by the manpower level to obtain the rate factors.

## USER PROCEDURES

A straightforward Lotus 1-2-3 spreadsheet update is used to calculate new factors and rates. Subsequent use is guided by the budget question to be answered. The put-and-take model is updated with each new MPA budget submission, so rates remain current.

## ASSESSMENT OF USER FRIENDLINESS

The model is fairly user friendly, but no documentation exists beyond the spreadsheet itself.

## COST ELEMENTS ADDRESSED

- Training costs – compensation is provided only while individuals are in training status.
- Health costs – no.
- Retirement accruals – yes.
- PCS – yes.
- Accession/recruitment – yes.
- MOS/specialty pays or bonuses – yes.
- Military/civilian pays – Military.
- Other services – no.

## MANPOWER QUESTIONS ADDRESSED

- Unit conversions – yes, as reflected in personnel changes
- Redeployments – partially in manpower PCS costs
- Inactivations – yes, as reflected in personnel changes
- Base closures and realignments – no

- Active/reserve mix – active MPA only
- Budget/program crosswalks – budget only.

## FY92 CONTRACT COSTS

Sustainment costs are zero; recurring development costs are zero.

## VERIFICATION AND VALIDATION

No formal V&V has been conducted, but the model has a successful performance history.

## OVERALL MODEL ASSESSMENT

The put-and-take rates model performs useful marginal budget adjustments at extremely low investment of time and effort. Rates are used to make adjustments to MPA budget submissions until a subsequent run of the MPA model is conducted. For this limited purpose, the model is satisfactory.

# THE ARMY MANPOWER COST SYSTEM (AMCOS)

## OBJECTIVE

The objective is to provide life-cycle cost (LCC) estimates and limited budget analyses for Army active, reserve, and civilian component manpower. Each force component is modeled by a separate stand-alone AMCOS model.

## USERS

The U.S. Army Cost and Economic Analysis Center (CEAC) and others are the primary users.

## DEVELOPER/MOST RECENT UPDATE

The system was developed by Systems Research and Applications, Inc. (SRA)/May, 1991.

## HARDWARE/SOFTWARE REQUIREMENTS

Each AMCOS model is run at user locations on PCs as a stand-alone model without interconnections.

## DATA INPUT REQUIREMENTS/SOURCES

The AMCOS model requires manpower personnel profiles for the portion of the force being analyzed by grade and specialty as well as cost factors and rates (percentage of personnel analyzed receiving separate rations, number receiving specialty pay, number under each retirement plan, etc.).

## OUTPUTS

Twenty-year life-cycle cost estimates are projected by budget appropriation. Special screens allow users to process data or tailor analyses. Personnel composition and strength and pay category tables can be accessed for ad hoc queries.

## METHODOLOGY

The model uses data arrays from the latest available DFAS and MPA budget justification books to determine cost factors. An appropriate force structure is selected for analysis. Users then use logic

switches within AMCOS to match the appropriate cost factors to the force and problem being analyzed.

## USER PROCEDURES

Users modify default data bases and create personnel profiles to address each question under analysis. Help screens assist manual data entry. Logic switches can be set to include or exclude appropriate cost elements. Choices can be made from a master menu to allow report formatting or limited budget analyses.

## ASSESSMENT OF USER FRIENDLINESS

Each AMCOS model has a clearly written user manual and numerous help screens. A user can alter data factor values for excursions and explorations. Users change only the data arrays rather than the underlying model assumptions or algorithms. Default conditions are identified if the user does not specify appropriate data changes. These user-friendly features allow inexperienced users to operate with reasonable model defaults to "get started" and yet allow more experienced users to tailor the AMCOS model to their application.

## COST ELEMENTS ADDRESSED

- Training costs – individual soldier compensation while in training; total costs of training are not addressed.
- Health costs – no
- Retirement accruals – yes
- PCS – yes
- Accession/recruitment – no
- MOS/specialty pays or bonuses – yes
- Military/civilian pays – Military in active and reserve models; civilian in civilian model
- Other services – no.

## MANPOWER QUESTIONS ADDRESSED

- Unit conversions – within component, not between RC/AC in one model
- Redeployments – partial

- Inactivations – yes
- Base closures and realignments – yes, personnel costs only
- Active/reserve mix – yes, active and reserve portions considered separately by specific model
- Budget/program crosswalks – yes.

## FY92 CONTRACT COSTS

Sustainment costs are $30,000 – $70,000; recurring development costs are zero.

## VERIFICATION AND VALIDATION

There is evidence that the Army Research Institute performed some V&V, but errors of small magnitude currently exist in some cost elements.

## OVERALL MODEL ASSESSMENT

The AMCOS models perform manpower cost analyses on three separate components from a user-friendly menu screen. The separate models do not interact. Users can tailor personnel profiles to each analytic task, but they cannot easily adjust cost factors. (They can switch factors on or off, but they cannot change magnitude.) AMCOS has underlying data of pay rates, FICA, strength, and disposition that should be common to all manpower costing models. This data organization blends personnel flexibility with fixed-cost data and meets the needs of LCC analysts. The budget analysis features are not widely used. AMCOS has many desirable features which make it user friendly.

# ENLISTED PERSONNEL INVENTORY, COST, AND COMPENSATION (EPICC) MODEL

## OBJECTIVE

The objective is to calculate the combined effects of personnel policy changes over time. EPICC demonstrates the interactions that occur between policy decisions, costs, and personnel inventories. EPICC models the effects that relate inventory assessments and cost implications to changes in compensation or personnel policies.

## USERS

ODCSPER is the main user.

## DEVELOPER/MOST RECENT UPDATE

SRA is the developer/August 1991.

## HARDWARE/SOFTWARE REQUIREMENTS

The model is PC based, with EPICC software.

## DATA INPUT REQUIREMENTS/SOURCES

The model takes baseline data on retention rates and fiscal year personnel inventories from the Defense Manpower Data Center (DMDC), while cost factors come from AMCOS. Specific scenario assumptions such as compensation, personnel policy changes, and cost assumptions are input by users.

## OUTPUTS

The EPICC model captures the first-order effects of changes in personnel policies, inventories, or cost factors as well as the second-order interaction effects. End strength and associated costs are provided for each scenario.

## METHODOLOGY

The model's methodology includes a projection of end strengths and costs built on three process modules used to examine policy changes: compensation, inventory, and cost estimation. The EPICC software performs the integration routines that capture the interactions of the policy, inventory, and cost changes. Users input

changes to the baseline data as compensation, promotion, macroeconomic factors, grade strength and requirements, losses, and accessions. The model provides detailed inventory adjustments and personnel costs. Scenarios (personnel policies or costs) can be modified as desired by the user.

## USER PROCEDURES

The user first specifies input data bases, then operates from menu-driven screens to reflect scenario inputs. The integration of policies and forces saves the user the time required to run and rerun personnel models operating as stand-alones. The effects of changes in one parameter set can be portrayed as outputs.

## ASSESSMENT OF USER FRIENDLINESS

The model is user friendly, has help screens, and is menu-driven. Users can select output displays. The interactions of policies and forces built into EPICC may not always represent the execution of personnel policy decisions.

## COST ELEMENTS ADDRESSED

- Training costs – yes
- Health costs – yes
- Retirement accruals – yes
- PCS – yes
- Accession/recruitment – yes
- MOS/specialty pays or bonuses – yes
- Military/civilian pays – yes
- Other services – no.

## MANPOWER QUESTIONS ADDRESSED

- Unit conversions – partially
- Redeployments – no
- Inactivations – yes
- Base closures and realignments – no

- Active/reserve mix – yes
- Budget/program crosswalks – no.

## OVERALL MODEL ASSESSMENT

The EPICC model is a user-friendly model developed with close coordination between sponsor and developer to reflect user needs. Although it is valuable to examine the integration effects of personnel policies and inventories, the outcome in practice may not be as predictable as the model indicates. The model would benefit from empirical comparisons of predicted interaction effects and field data. The model is not currently used by ODCSPER.

# INDIVIDUAL TRAINING PREDICTIVE MODEL

## OBJECTIVE

The objective is to provide estimates of the impact of force-structure and end-strength changes on operations and maintenance funding requirements for individual training.

## USERS

The primary model users are agencies within HQDA.

## DEVELOPER/MOST RECENT UPDATE

The model was developed by Automation Research Systems, Limited/April 1991.

## HARDWARE/SOFTWARE REQUIREMENTS

The model is run on IBM-compatible PCs in users' offices. Hardware and software configurations will vary as a function of individual user requirements. Minimal hardware components are required to operate ITPM, including a 80286 processor with 512 kilobyte base memory; a 20-megabyte fixed-disk drive, and one 5.25" floppy disk drive for storage. Input-output devices must include, as a minimum, a monochrome monitor with a color graphics adaptor (CGA) board and a wide-carriage dot matrix printer. Basic software must include a version of MS-DOS between 3.1 and 4.01 for the operating system, dBASE III Plus for data base management, and other specialized software packages. The model is an unclassified system and requires no security beyond normal office safeguards.

## DATA INPUT REQUIREMENTS/SOURCES

The model uses information drawn from a number of sources, including the following:

(1) The DFAS provides information on historical obligation data for individual training.

(2) The Army Training Requirements and Resources System (ATRRS) provides training loads by category and military occupational specialty (MOS).

(3) The Personnel Structure and Composition System (PERSACS) provides force structure information.

(4) The MOS Level System (MOSLS) provides projections of total, trained, and operating strength, losses re-enlistments, and promotions at the MOS/grade/years-of-service level of detail.

(5) The user can enter various alternatives to the force structure.

(6) The PROBE data base provides information on prior and current budgets and future program projections.

## OUTPUTS

The model produces reports on the baseline case and alternatives, reflecting:

(1) Crosswalks of historical financial data by Army Management Structure Code (AMSCO) and Management Decision Package (MDEP)

(2) Budget estimates for Individual Training (Program 8 of the budget) by AMSCO and MDEP

(3) Comparison reports between model estimates and one or more PROBE positions

(4) MOS imbalance reports based on changes in end strengths or force structure

(5) Training loads by categories based on changes in the force structure and/or end strength, using the updated imbalance report

(6) Training loads needed for selected force levels and readiness postures

(7) Costs associated with the identified training loads, calculated using different cost projection methods

(8) Training support costs that will be added to the direct training load costs

(9) Manpower requirements and related costs that support the identified training load.

## METHODOLOGY

The user establishes an alternative to current force structure by entering unit identification codes (UICs) of units to be added or deleted. The model identifies the effects of the unit change in terms of MOSs and compares the changes to the current and projected MOS inventories. The model then calculates new training requirements and loads to support the alternative.

The model estimates these impacts for recruit training, one-station unit training, officer acquisition training, senior ROTC, specialized skill training, flight training, professional development education, and training support. The model does not estimate the effects of force-structure changes on base operations or real property maintenance for bases where individual training is conducted, nor does it address individual resources for medical training.

## USER PROCEDURES

The user chooses an alternative for analysis by entering UICs of units proposed for addition to or deletion from the force structure.

## ASSESSMENT OF USER FRIENDLINESS

There are plenty of help screens, the menus are straightforward, and there are built-in error indicators. Algorithms for calculating costs are not displayed for the user, and therefore sensitivity analyses to examine cost effects of changes in predictive parameters are not possible.

## COST ELEMENTS ADDRESSED

- Training costs – yes
- Health costs – no
- Retirement accruals – no
- PCS – no
- Accession/recruitment – no
- MOS/specialty pays or bonuses – no
- Military/civilian pays – no
- Other services – no.

## MANPOWER QUESTIONS ADDRESSED

Unit conversions – yes. (For example, the user can delete an AC unit identifier cose (UIC) and add a RC UIC, and the resource effects for the training base can be estimated.)

- Redeployments – no
- Inactivations – yes
- Base closures and realignments – no
- Active/reserve mix – yes, in the manner discussed in "unit conversions" above
- Budget/program crosswalks – yes.

## OVERALL MODEL ASSESSMENT

The model accomplishes its objective of providing an analytical tool for gauging the effects of a force-structure or end-strength change on the training base. The model must be updated fairly frequently to reflect the current force structure, end strengths, and training budgets.

The ITPM is not, per se, a model to be used for estimating manpower costs, but it can provide inputs to assist such analyses.

# THE ARMY FORCE COST SYSTEM (TAFCS)

## OBJECTIVE

The objective is to estimate the total costs of various force structure alternatives.

## USERS

CEAC is the main user.

## DEVELOPER/MOST RECENT UPDATE

Management Analysis Incorporated (MAI) is the developer/1992.

## HARDWARE/SOFTWARE REQUIREMENTS

The model is PC based. Thirty megabytes of memory storage are required. New enhancements to the model are planned, which may increase requirements.

## DATA INPUT REQUIREMENTS/SOURCES

Data bases with SRC, force structure, personnel composition, and personnel costs by category are integral to TAFCS. Users input the appropriate composition of force structure for analysis.

## OUTPUTS

The TAFCS provides personnel, equipment, and operating cost estimates for the defined force. This force cost can be used to reflect differences in stationing decisions, eliminations, or force conversions. TAFCS output allows a review of each category of costs and allows a comparison of alternatives.

## METHODOLOGY

Users select the force to be analyzed from available SRCs and division files. Users specify cost factors that are appropriate for the analysis undertaken and choose which TAFCS cost categories will be applied. TAFCS uses the force structure specified and calculates the personnel and equipment costs.

## ASSESSMENT OF USER FRIENDLINESS

Menu-driven screens allow the user to readily access data built into TAFCS. There are no screens that allow an analyst to deviate from existing SRCs or units, modify cost factors, nor disable costs built into TAFCS.

## COST ELEMENTS ADDRESSED

- Training costs – yes
- Health costs – yes
- Retirement accruals – yes
- PCS – yes
- Accession/recruitment – yes
- MOS/specialty pays or bonuses – yes
- Military/civilian pays – Military
- Other services – no.

## MANPOWER QUESTIONS ADDRESSED

- Unit conversions – no, it addresses active Army only.
- Redeployments – no.
- Inactivations – yes.
- Base closures and realignments – no.
- Active/reserve mix – no, only changes to the active Army.
- Budget/program crosswalks – no.

## OVERALL MODEL ASSESSMENT

The TAFCS model is easy to run but does not meet the needs of many analysts to examine in detail the costs of new equipment, active/reserve total force mix alternatives, or emerging force structures. This limits the effectiveness of the model as a manpower costing tool.

# APPENDIX B

# EXAMPLE COMPARISON OF THE AMCOS AND PUT-AND-TAKE MODELS

## INTRODUCTION

One of the major issues in this study is to determine the amount of overlap present among Army manpower costing models. Not surprisingly, we found that the true extent of the overlap or duplication between any two cost models may not be apparent from short, high-level descriptions of the models. The existence of differences in the model details does not necessarily indicate the presence of errors. Two models may be designed to answer different questions.

We compared the AMCOS (active) model and the put-and-take model to examine the issue of model overlap. Both models are capable of analyzing manpower budget questions for active Army personnel. Because the models were developed for different purposes, they do not contain the same cost elements, nor do they always use identical algorithms for their common cost elements.

The next section recaps the basic features of the AMCOS (active) budget model and the put-and-take model. Included are tables summarizing the cost elements. The third section of this appendix presents a numerical comparison based on a fictional 1,000-soldier unit. The last section discusses the AMCOS model anomalies that we found in this exercise.

## MODEL FEATURES AND COST ELEMENTS

The put-and-take model was developed by ASA(FM) budget analysts to support their work on the Military Personnel, Army (MPA) budget. Accordingly, its cost elements are those elements used in the MPA budget. In contrast, the AMCOS model was designed to provide LCC estimates and includes cost elements from

budgets other than MPA, such as recruiting, officer acquisition, selected re-enlistment bonuses, and training. The AMCOS model includes logic switches that allow the user to select appropriate cost elements to include for a particular analysis.

A scan of Table B-1 shows that the models cannot be compared by simply matching cost elements. While most MPA cost elements are common to both models, there are some differences. The following cost elements appear only in the put-and-take model: general officer allowance, temporary living allowance, and adoption expenses. The MPA cost elements that appear only in the AMCOS model are as follows: officer acquisition; recruiting; re-enlistment bonuses; training; the new GI bill; and morale, welfare, and recreation (MWR). None of those elements is of sufficient magnitude to cause significant differences in estimates from the two models.

Common cost elements may be estimated differently. For instance, the permanent change of station (PCS) cost for officers varies by grade in the AMCOS model but is fixed for all grades in the put-and-take model. Both models estimate some costs by multiplying a cost rate times the fraction of personnel who receive the rate. Typically, the AMCOS model derives the fraction from the last *MPA Justification* book of the just-completed fiscal year. In contrast, the put-and-take model's fractions may include consideration of additional historical data and projections based on anticipated trends and policy changes. In addition, the AMCOS model allows a user to specify the personnel profile as "all Army" or as MOS specific and uses the selected profile over the entire period being analyzed. The put-and-take model uses the personnel profile for the budget year from the MPA model.

We show the average costs by grade for specific pay categories for each model in Table B-2 and Table B-3. As shown in these tables, there are some substantial differences between the average soldier costs for the two models, especially in the areas of BAQ, VHA, PCS, special pays, and other benefits. Two categories, basic pay and retirement pay accrual, account for some 75 percent of the total annual soldier cost estimates. Basic pay rates were adjusted to reflect each model's use of FY92 dollars, but differences remain when grade-by-grade comparisons are made. Retirement pay accrual percentages are specified by statute, and these categories are within a percentage point for the two models. The small differences in basic pay and retirement pay accrual may be the result of one model's use of a different mix of lengths of service to calculate the rate for a specific grade. Thus, the models are in agreement on the largest contributors and on total estimates of a soldier's annual costs.

**Table B-1. MPA Cost Elements used in Active Army Budget Analysis Models**

| Put-and-take model | AMCOS (active) model |
|---|---|
| Base pay | Military compensation |
| Variable housing allowance | Base pay |
| Basic allowance for quarters | Variable housing allowance |
| With dependents | Basic allowance – quarters |
| Without dependents | In-kind |
| Partial | In-cash |
| Inadequate housing | Basic allowance – subsistence |
| Basic allowance for subsistence | Retired pay accrual |
| Retired pay accrual | Special pays |
| Flight pay | Hazardous duty |
| Physician/dentist | Sea/foreign duty |
| Veterinarian | Medical personnel |
| Optometrist | Diving duty |
| Parachute | Overseas allowances |
| Sea duty/diving | Special duty assignments |
| Other hazard | Officer acquisition |
| General officer allowance | Recruiting |
| Cost of living allowance | Re-enlistment bonuses |
| Overseas housing allowance | Training |
| Temporary living allowance | Permanent change of station |
| Initial uniform allowance | Rotational |
| Additional uniform allowance | Operational |
| Separation – two homes | Training |
| Separation – other | Accession |
| Lump-sum terminal leave | Separation |
| Other severance | Other benefits |
| Social Security | Survivor benefits |
| Permanent change of station | Separation costs |
| Other military personnel costs | Social Security |
| Adoption expenses | Death gratuities |
| Apprehension of deserters | Unemployment compensation |
| Death gratuities | Family separation allowance |
| Unemployment compensation | Apprehension of deserters |
| Survivor benefits | Clothing allowances |
| Education benefits | Morale, welfare, and recreation |
| | New GI bill |

## Table B-2. AMCOS Cost Element Rates (FY92 $000s)

| | Basic pay | RPA | BAQ and VHA | BAS | PCS | Special pays | Other benefits | Total |
|---|---|---|---|---|---|---|---|---|
| **Officer grade** | | | | | | | | |
| 0-7 | 74,469 | 32,171 | 2,605 | 1,611 | 4,800 | 752 | 9,634 | 126,042 |
| 0-6 | 61,602 | 26,612 | 5,604 | 1,611 | 4,366 | 2,071 | 6,912 | 108,778 |
| 0-5 | 51,221 | 22,127 | 6,288 | 1,611 | 4,137 | 2,855 | 5,862 | 94,101 |
| 0-4 | 41,807 | 18,061 | 5,333 | 1,611 | 3,879 | 2,925 | 4,029 | 77,645 |
| 0-3 | 34,237 | 14,790 | 4,205 | 1,611 | 3,462 | 2,360 | 3,515 | 64,180 |
| 0-2 | 27,493 | 11,877 | 3,181 | 1,611 | 3,333 | 2,347 | 3,473 | 53,315 |
| 0-1 | 19,192 | 8,291 | 2,751 | 1,611 | 2,653 | 2,116 | 1,746 | 38,359 |
| W-4 | 37,730 | 16,299 | 5,043 | 1,611 | 4,078 | 748 | 5,014 | 70,532 |
| W-3 | 31,687 | 13,693 | 4,161 | 1,611 | 3,547 | 752 | 3,610 | 59,061 |
| W-2 | 26,241 | 11,336 | 3,242 | 1,611 | 3,281 | 754 | 2,762 | 49,227 |
| W-1 | 21,808 | 9,421 | 2,715 | 1,611 | 2,748 | 759 | 1,964 | 41,026 |
| **Enlisted grade** | | | | | | | | |
| E-9 | 32,859 | 14,195 | 3,973 | 1,352 | 957 | 123 | 3,601 | 57,060 |
| E-8 | 26,840 | 11,595 | 4,414 | 1,352 | 893 | 160 | 2,800 | 48,054 |
| E-7 | 22,541 | 9,738 | 3,773 | 1,352 | 813 | 168 | 2,283 | 40,668 |
| E-6 | 18,775 | 8,111 | 3,212 | 1,352 | 737 | 159 | 1,905 | 34,251 |
| E-5 | 15,692 | 6,779 | 2,481 | 1,352 | 620 | 146 | 1,781 | 28,851 |
| E-4 | 13,122 | 5,669 | 1,709 | 1,352 | 556 | 159 | 1,708 | 24,275 |
| E-3 | 10,469 | 4,523 | 879 | 1,352 | 273 | 120 | 1,480 | 19,096 |
| E-2 | 10,469 | 4,523 | 879 | 1,352 | 273 | 120 | 1,480 | 19,096 |
| E-1 | 10,469 | 4,523 | 879 | 1,352 | 273 | 120 | 1,480 | 19,096 |

*Notes:* RPA = retirement pay accrual, BAQ = basic allowance for quarters; VHA = variable housing allowance; BAS = basic allowance for subsistence; PCS = permanent change of station.

**Table B-3. Put-and-Take Cost Element Rates**
**(FY92 $000s)**

| | Basic pay | RPA | BAQ and VHA | BAS | PCS | Special pays | Other benefits | Total |
|---|---|---|---|---|---|---|---|---|
| **Officer grade** | | | | | | | | |
| 0-7 | 74,104 | 31,642 | 3,366 | 1,597 | 4,294 | 1,621 | 6,607 | 123,231 |
| 0-6 | 62,116 | 26,524 | 7,790 | 1,597 | 4,294 | 6,144 | 7,351 | 115,716 |
| 0-5 | 51,077 | 21,810 | 8,649 | 1,597 | 4,294 | 2,704 | 5,964 | 96,095 |
| 0-4 | 41,616 | 17,770 | 6,998 | 1,597 | 4,294 | 3,598 | 5,021 | 80,894 |
| 0-3 | 33,938 | 14,492 | 5,387 | 1,597 | 4,294 | 2,442 | 5,772 | 67,922 |
| 0-2 | 26,760 | 11,427 | 3,797 | 1,597 | 4,294 | 712 | 2,852 | 51,439 |
| 0-1 | 19,600 | 8,369 | 3,279 | 1,597 | 4,294 | 453 | 1,991 | 39,583 |
| W-4 | 38,276 | 16,344 | 6,587 | 1,597 | 4,294 | 3,901 | 5,030 | 76,029 |
| W-3 | 31,486 | 13,445 | 5,286 | 1,597 | 4,294 | 3,245 | 5,183 | 64,536 |
| W-2 | 25,716 | 10,981 | 4,000 | 1,597 | 4,294 | 1,529 | 2,816 | 50,933 |
| W-1 | 21,584 | 9,216 | 3,404 | 1,597 | 4,294 | 2,003 | 2,302 | 44,400 |
| **Enlisted grade** | | | | | | | | |
| E-9 | 33,563 | 14,331 | 5,347 | 1,429 | 1,641 | 193 | 5,355 | 61,859 |
| E-8 | 27,708 | 11,831 | 5,040 | 1,429 | 1,641 | 203 | 4,550 | 52,402 |
| E-7 | 23,247 | 9,926 | 4,280 | 1,429 | 1,641 | 203 | 3,729 | 44,455 |
| E-6 | 19,411 | 8,288 | 3,524 | 1,429 | 1,641 | 215 | 3,303 | 34,508 |
| E-5 | 16,163 | 6,902 | 2,715 | 1,429 | 1,641 | 227 | 3,169 | 29,077 |
| E-4 | 13,078 | 5,584 | 1,900 | 1,429 | 1,641 | 201 | 2,973 | 26,806 |
| E-3 | 11,085 | 4,733 | 1,211 | 1,429 | 1,641 | 193 | 2,619 | 22,911 |
| E-2 | 10,428 | 4,453 | 916 | 1,429 | 1,641 | 188 | 2,544 | 21,599 |
| E-1 | 9,292 | 3,968 | 529 | 1,429 | 1,641 | 180 | 4,976 | 22,015 |

# A NUMERICAL COMPARISON

We estimated the 1-year MPA budget cost of a fictional 1,000-soldier active Army unit using both the AMCOS (active) and the put-and-take models. The purpose of the exercise was to improve our understanding of each model and to highlight major similarities and differences.

Table B-4 shows the assumed distribution of personnel.

**Table B-4. Composition of Fictional Unit**

| Enlisted | | Warrant | | Officer | |
|---|---|---|---|---|---|
| E-1 – 3 | 210 | W-1 | 3 | 0-1 | 12 |
| E-4 | 260 | W-2 | 10 | 0-2 | 20 |
| E-5 | 165 | W-3 | 5 | 0-3 | 50 |
| E-6 | 120 | W-4 | 2 | 0-4 | 25 |
| E-7 | 70 | | | 0-5 | 15 |
| E-8 | 20 | | | 0-6 | 7 |
| E-9 | 5 | | | 0-7 | 1 |

For the AMCOS model, the computations were done in FY91 dollars and then inflated by the standard 4.04 percent FY91 to FY92 factor to obtain FY92 dollars. We used the budget model option with average costs for "all Army" (branch 00, in AMCOS notation). The BAQ and the VHA estimates are for the actual cash payments only (i.e., in-kind payments are excluded). Retirement pay accrual (RPA) is based on the DoD actuarial method. The cost elements included are: basic pay, BAQ, VHA, BAS, RPA, other benefits, and special pays. We omitted the cost elements that are not in the put-and-take model, namely officer acquisition, recruiting, re-enlistment bonuses, and training, GI Bill, and MWR. Also, we omitted the PCS cost since the models treat it differently and the treatments are not clearly documented.

The put-and-take model estimates costs in FY92 dollars and is based on the FY92/93 President's Budget. We used the "composite standard" rates less PCS cost, which includes all cost elements under the put-and-take model in Table B-1 (except PCS).

Table B-5 shows the estimates from the two models. The put-and-take model estimate is 4.4 percent higher than the AMCOS estimate. The enlisted personnel category shows a larger difference (in both absolute and proportional terms) than the officer category.

**Table B-5. Estimated Annual Budget Costs for a Fictional 1,000-Soldier Unit (FY92 $millions)**

| Model | Enlisted | Officer | Total |
|---|---|---|---|
| AMCOS | 24.20 | 9.59 | 33.79 |
| Put-and-take | 25.34 | 9.95 | 35.29 |

We attempted to quantify the differences between the models. The cost elements that appear in the put-and-take model but not in the AMCOS model only account for about 6 percent of the difference between the estimates. Basic pay rate differences account for about 20 percent of the difference between the estimates. We identified one apparent error in the AMCOS model. The error, which is discussed below, explains about one-half percent of the difference between the two models. In our review of common cost elements, we found variations of several percentage points between the two models. Simply using different Army strength-by-grade figures, such as average vs. end-year, can result in differences of several percentage points. For example, applying the AMCOS VHA rates to the average strength for FY91 gives an estimate of $273.7 million. The actual FY91 VHA total is $283.7 million, which is almost 4 percent higher. Further explanation of the numerical difference was limited by the differences in cost elements and the available documentation.

We see no pattern (e.g., AMCOS model estimates are not always higher than put-and-take model estimates) in the rates from model to model. The 4.4 percent cost difference will not be constant; if a different mix of personnel is selected, the difference could be more or less than in our example. We are left with the conclusion that when models have overlapping functional capabilties [as in the case of AMCOS (active) and put-and-take] the potential exists that different cost estimates can be generated for the same cost question.

## AMCOS ANOMALIES

We uncovered several anomalies in the course of comparing the AMCOS model with the put-and-take model. We obtained copies of the latest models and supporting documentation, ran the models, and discussed the results with model proponents and developers.

The ASA(FM) developed the put-and-take model as an in-house tool and has not developed documentation for the model. Although the Lotus 1-2-3 calculation algorithms used in the put-and-take model are clear, the development of the cost factors shown in Table B-3 is not described. We focused our efforts to resolve the anomalies between the two models on an investigation of AMCOS.

Our investigation of AMCOS indicates there is one error in the model, two errors in the documentation, and some detail lacking in the documentation.

The model errs in its estimate of "VHA in-kind." The conceptual meaning of VHA in-kind is the average rate of VHA for all personnel within a grade. (This definition is analogous to the definition used for "BAQ in-kind.") We use an example for one grade to demonstrate the problem.

According to the *MPA Justification* book (January 1992), the amount of VHA paid to O-6s (colonels) in 1991 was $8,415,000. The number of O-6s was 4974 and 2,575 of them received VHA. The average VHA rate for 0-6's rate should be computed as $1,692, $8,415,000 divided by the total number of 0-6's, 4,974. The AMCOS model data base shows a rate of $9.80, which is in error by over two orders of magnitude. The rates for other officers are also in error by large amounts. The errors for most enlisted personnel grades are approximately 30 percent. For the 1,000-soldier test case, the AMCOS model VHA estimate is $197,000, while the amount based on the *MPA Justification* book is $363,000.

The existence of the VHA computation error raises a question about the attention that has been given to verification and validation of the AMCOS model.

We noted two errors in the documentation. One error is an extra reference to a cost element. Family separation allowance (FSA) is described as a component of both "other benefits" and "special pays." Based on our review of the computations, we believe the FSA computation should be in the special pays section only.

The second documentation error involves the definition of weighting factors used in the BAQ computations. The current printed definitions of the factors allow negative values for cost quantities that must be zero or positive. According to the contractor, the actual computations use the correct definitions (and the correct values derived from the *MPA Justification* book), and the documented definitions are in error.

We found the documentation to be helpful. However, there are several issues that could be more clearly discussed. For instance, the discussion of special pays indicates general rules for assigning the pays to military occupation specialties (MOSs). Some pays are applied to all MOSs as average rates, while other pays are restricted to specific MOSs. However, we were unable to determine from the documentation exactly which special pays are applied when the "all Army" option ("branch 00") is selected.

The discussion of medical benefits clearly states how costs incurred in the civilian sector are treated, but the materials are unclear on the treatment of military hospital costs. The documentation states that the calculations will not include the cost of the facilities or the military pay of doctors and other military personnel. This statement is followed by an equation that calculates the average Operations and Maintenance, Army (OMA) cost per person for operating all military medical facilities. Also, the cost data base in the model contains entries for medical support. The documentation does not precisely state which military medical costs are included and excluded.

The model includes training costs in the MPA appropriation. In particular, it includes the pays and allowances of students and instructors. If we had included those training costs in the fictional 1,000-soldier unit, then we would have double-counted pays and allowances for the average annual time that the unit personnel are in training. The documentation does not mention this issue.

The AMCOS model documentation could be improved by eliminating the errors and clarifying the ambiguities. We think that a detailed review of the cost generation algorithms could explain how data were placed into appropriate model categories, how specific entries by pay grade were calculated, and why specific numerical differences occurred in our example. Investigation by a verification and validation team or by users/proponents of the two models would further the V&V efforts that our example identified as necessary.

# APPENDIX C

# AN ARCHITECTURE FOR A SINGLE MULTIPURPOSE MODEL

## CONCEPTUAL ARCHITECTURE

It has been suggested that a single, multipurpose manpower costing model could replace existing models and save money without losing analytical capability. We developed a simple, conceptual architecture which shows the functions performed by a single, multipurpose model. We then used this architecture to investigate the advantages and disadvantages of a single model.

A single model must perform all of the manpower cost analysis tasks that could be performed by the current set of models we reviewed. We show the models which now perform the function in Figure C-1. The single model must support budget preparation, budget analysis, and life-cycle cost estimation for the Army's active, reserve, National Guard, and civilian personnel. Because the active, reserve/guard, and civilian components have different structures for pay and benefits, data files and processing algorithms for those manpower categories must be different. In addition, budget analysis and LCC analysis each treat costs differently and thus require different algorithms.

Figure C-1 presents one conceptual architecture with the minimal features required of a single model. We show an executive control module that allows the analyst to select the appropriate component of the total force for analysis. A data module is shown which contains data used globally by the component models. Within each manpower component category, the user would select budget preparation and analysis or LCC estimation modules and specify which data elements from the global data module to include.

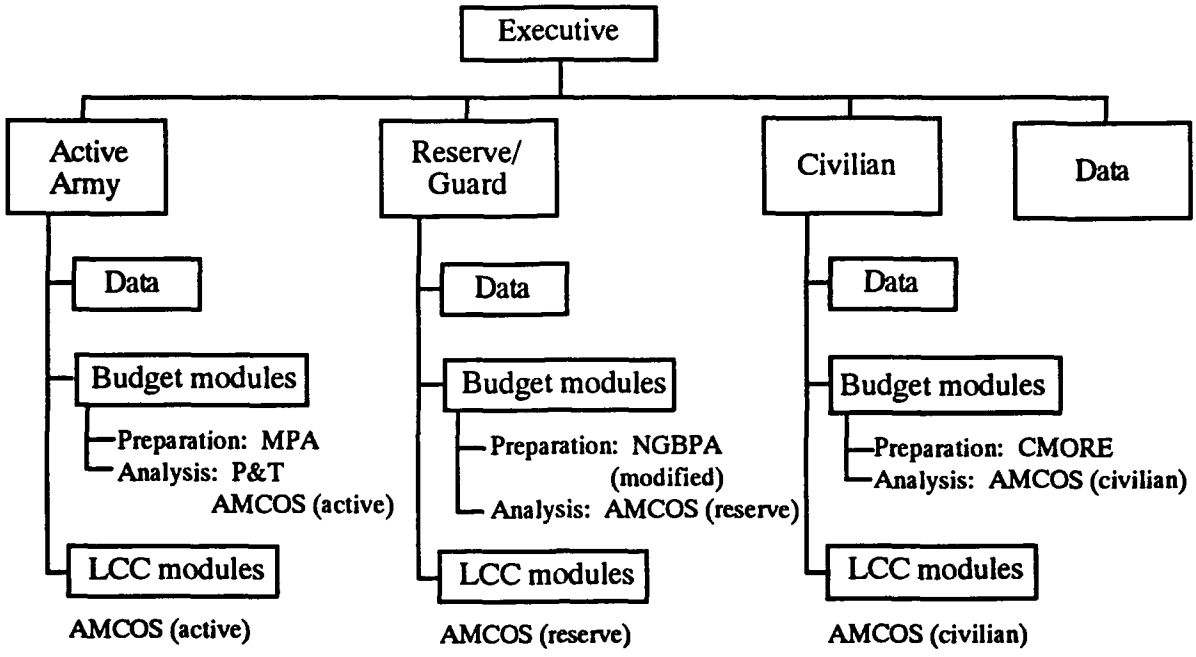


**Figure C-1. Single Personnel Cost Model Architecture Using Existing Manpower Models**

Once a component is selected for analysis, the user has access to costing routines which support the budget or LCC analyses. Within each analysis module (budget or LCC), we identify the models that currently must be used to meet the minimum functional requirements. The listing of the put-and-take model and the AMCOS (active) model under the budget module of the active Army illustrates that both models are currently needed.

# FUNCTIONAL REQUIREMENTS

The multipurpose model shown in Figure C-1 is representative of a single model that could perform the manpower cost functions currently found in selected existing Army cost models by running each of the existing models from a master data base. In basic terms, each model has three components: a set of cost factors organized by personnel category, a personnel profile whose categories match those of the cost factors, and a set of algorithms that match costs to personnel and aggregate the results into specific output categories. The multipurpose model would allow a complete analysis for each component budget and LCC module and would format outputs in budget or LCC form.

Within each component, budget preparation, budget analysis, and LCC estimation functions require a model whose data elements and algorithms closely match the unique requirements of its component. Those models are shown in Figure C-1.

Two cases should be noted. The only significant overlap is between the put-and-take and AMCOS (active) models. Both models generate aggregate budget estimates and are used for "what if" analysis. Each model has unique characteristics that should be represented in the single model architecture. The put-and-take model uses the same cost categories as the MPA budget, which ASA(FM) requires for its budget analyses. The AMCOS (active) model uses different cost categories, which makes it undesirable for ASA(FM), but it contains additional cost elements in the Operations and Maintenance, Army (OMA) program that can be impacted by manpower decisions. (Some examples are training, officer acquisition, and medical benefits.) Because the single model should support ASA(FM)'s needs for complete "what if" budget analysis, the capabilities of both the put-and-take model and the AMCOS (active) model are included. For the reserve/guard block, the NGBPA model provides the budget preparation capability and the AMCOS (reserve) models allows budget analysis. In this case, the NGBPA model is modified to reflect a combination of features of the current NGBPA and RPA models.

A single, multipurpose model would have to incorporate distinct capabilities from at least seven of the models examined to match the current capability to perform budget preparation and analysis and LCC estimation.

The conceptual architecture in Figure C-1 makes extensive use of the AMCOS models. One of the AMCOS models appears in each of the six model areas. This suggests that the combined AMCOS models could serve as the core or starting point for a single, multipurpose model. Additional models would still be needed to prepare the formal budgets and to support other specialized needs.

One approach to constructing a single model with this architecture would be to proceed in stages. The first stage could be devoted to combining the three AMCOS component models into a single LCC model. The second stage could combine this "super-LCC" model with additional budget preparation models. The final stage could integrate the global data and executive control routines.